wards. Again, the emboli could only be discovered after much time and labor, which was not given.

This same explanation may be offered for the attacks of Feb. 3d and 5th, at which times the spasmodic movements were more circumscribed; and, if softening *did* occur after these attacks, it was probably overlooked, or collateral circulation was established; that is, if we adopt the views of Heubner, who believes the anastomoses of vessels of the pia mater supplying the cortex, to be very free, as opposed to the vessels supplying the basal ganglia.

We may mention, *en passant*, that the researches of Duret controvert this; as he has shown that the arteries of the cortex, like those of the base, do not anastomose, and are terminal.

In explanation of the spasmodic movements in walking, the strychnia, and the site of the softened patch in the right hemisphere are probably sufficient. Finally, we will only add, that for such cases as these, there is no relief, no cure; for, owing to the anatomical distribution of these vessels (at base of the brain), being terminal, without anastomoses, recovery is impossible; there can be no collateral circulation established.

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ART. VI.—EXPERIMENTAL AND CLINICAL INVESTIGATIONS ON CERVICAL PARAPLEGIA.

BY PROF. DR. M. ROSENTHAL.

[*Translated from Stricker's Jahrbuecher, IV.* 1876, *pp.* 381–400 *incl. by Dr. J. I. Tucker.*]

While typical paraplegia of the lower extremities has long been a common subject of medical observation, as much cannot be said of that rarer paraplegic affection, having its seat in the upper limbs, and designated by Gull,* as cervical para-

**Guy's Hosp. Rep.*, IV. 185.

plegia. The different anatomical conditions, the varying clinical features, as well as the peculiarities in regard to diagnosis, render this group of paralyses especially interesting, and call for further research and observation.

Inasmuch as the medical literature is very scanty concerning isolated section of the anterior cord, especially in the cervical region, as far as my knowledge extends, it seemed to me not superfluous to communicate the most important results of my own experiments. To these experimental data, the results of clinical observations can be added with advantage.

A. *Experimental production of paralysis of the fore limbs.*

The section, or partial section of the anterior cord in the cervical region, was performed on frogs. The experiments were twenty-five in number. If we take from a winter frog (*Rana esculenta*) a piece of the cord at the upper limit of the cervical enlargement, from the posterior columns forward, and from one side to the other, the animal exhibits a distorted position of the head, and paralysis of both fore limbs, which are directed inwards, are very slightly irritable to mechanical or electrical irritation, and serve only as immovable supports to the animal. In many cases, the hinder limbs also appear paretic. Besides this, the cutaneous sensibility is notably diminished above the wound, on the head.

Within the next 8 to 14 days, a marked improvement in the motility of the anterior limbs appears, especially in the toes. After death, which occurs with in a certain time, microscopic examination of the hardened cord shows deposits of a hyaline exudation around the nerve tubes, and numerous pus corpuscles collected in the gray horns, or grouped star-wise around the central canal.

In larger animals the cervical cord, from the posterior columns to the most anterior portion, can likewise be wounded. In a rabbit thus operated upon, there immediately appeared dyspnœa and a high degree of hyperæsthesia, with paralysis of both anterior limbs and the right posterior one. Slight pinching of the tail or the members, or electric irritation of the latter, caused, together with outcries on the part of the animal, powerful movements of contraction and

extension of the hind limbs, while the anterior ones remained perfectly immovable, even upon direct mechanical irritation. The autopsy showed perfect division of the posterior columns, and gray horns, as far as the anterior columns. Only a portion of the latter and the anterior cornua were uninjured. The hyperæsthesia was here dependent on the injury to the posterior columns, according to Woroschiloff, on the extension of the cut into the middle fibres of the lateral columns.

The anterior portion of the cord can be reached in rabbits by two kinds of operative procedure; either from the anterior or the posterior aspect of the cervical vertebræ. The incision, or excision of the cervical cord, from the front, can be managed in different ways. The easiest, but, at the same time, the most uncertain way, is to introduce the knife into an intervertebral space, laid bare for a little way, and cut forward. The usual result of this operation is paralysis of the corresponding fore limb, and paresis of the members, which latter disappears in a few days. The persistent paralysis of the anterior extremity is, as the post-mortem shows, due to a predominant lesion of the cord, on the side of the cut; the other half is only slightly, if at all, affected.

In order to make the cut of the anterior aspect of the cord more advantageously, the spinal canal must first be opened anteriorly. Still, this operation is not less tedious than dangerous, on account of the unavoidably severe hemorrhage, no matter whether the bone is pared away with a knife, or bored through and pinched off. If only one-half of the anterior cervical cord is operated upon, there follows paralysis of the corresponding fore and hinder limbs; if the injury still extends over the middle line into the two lateral columns, then we have paralysis of both fore limbs, generally with paresis of one posterior extremity. Later attempts at motion, on the part of the animal, lead to the conclusion that one fore limb is more paralyzed than the other, and that the extensors are specially affected, the flexors suffering very little. (A similar condition of things, as will be shown further on, is observed in cervical paraplegia of the human subject.)

In most cases the rabbits began to suffer from an intense dyspnœa shortly after the operation, soon followed by tetanic

cramps of the members. In the course of the same or the following day epileptiform convulsions set in, which phenomena (analagous to those sometimes observed in man) confirm during life the diagnosis of spinal apoplexy. The animal dies within 24 to 36 hours.

The autopsy generally reveals extensive meningeal extravasation, which extends downward on the dorsal cord and upwards on the medulla. Sometimes there is also an intra-medullary hemorrhage corresponding to the point of lesion.

A less difficult and dangerous operation is that from the hinder region of the cervical vertebræ. After the removal of the spinous and transverse processes of the upper cervical vertebræ, an aneurysm needle is introduced laterally into the cord, the veins, etc., being avoided, and then with a small knife, preferably one crooked toward the surface, an incision or excision of both halves on the anterior face of the cord is made.

Together with the above described paralysis of both anterior limbs, or of one hinder extremity also, the reflex power is also notably altered from the lesion of the gray matter. Thus I saw, in one animal thus operated upon, contractions of both posterior limbs follow electric irritation of one sciatic nerve, the fore limbs remaining meanwhile perfectly quiet. Irritation of one median nerve caused only contraction of the corresponding member, without exciting other contractions.

Examination of the hardened cord revealed a hemorrhage extending across both the white and gray substance in the cervical region. Only a narrow strip of the anterior portion of the latter was uninvolved. In lower sections the medullary substance becomes more and more free, both anteriorly and posteriorly, the hemorrhage becomes limited to the gray columns, and soon is only perceptible in the posterior column in the form of a fine point.

B. *Clinical observations on cervical paraplegia.*

In agreement with the experimental results, clinical observation shows that myelitic local lesions, extending downwards from the cervical region, involve first the upper and later generally the lower limbs in a paralysis. Sensibility and reflex action also suffer simultaneously more or less serious involvement. In caries of the cervical vertebræ, first one arm and

then the other suffers, paralysis, which, with its further extension, involves the legs also. Cases of this kind are met with in the older authors, such as Brodie, Marshall Hall, Nichet, Ollivier, Budd, and Schutzenberger. An acute myelitis of the cervical cord, from wrenching or fracture of the vertebræ, may also begin with paralysis. In a lately described case of Michaud* (gunshot wound of the anterior cervical region), with resulting paralysis of both arms, stiffness of neck, difficulty of swallowing, and final paralysis of the legs, the autopsy revealed a fracture of the fifth, sixth and seventh cervical vertebræ, compression of the cervico-brachial enlargement by a splinter, with corresponding softening of the anterior portion of the cord and extension of the incipient myelitis to the gray matter and the posterior columns. The anterior roots as well as the brachial nerves showed neuritic alterations (fatty granular degeneration).

Finally, paralysis and contraction of the upper members may be induced by compression of the cord at the level of the upper dorsal vertebræ from caries, and, according to Charcot and Michaud, by sclerosis of the lateral columns extending up to the cervical region. Louis has reported a case of this kind† without, as he himself admits, being able to explain the anomaly.

That the region of origin of the brachial nerves extends from the fifth cervical to the third dorsal vertebra, is also indicated by the fact that paralysis of the arms and dorsal regions belong to the initial symptoms of circumscribed cervical myelitis. The frequent partial loss of sensibility is also due to this slight extension of the spinal lesion, as is likewise observed in the experimental wounding of the cervical cord. In a very recently described case of spinal lesion at the level of the seventh cervical vertebra, by Hutchinson,‡ there was during life, besides constriction of the pupil and diaphragmatic respiration, also imperfect paralysis of the upper extremities. The triceps, the extensors and the pronators were paralyzed, the flexors merely weakened, the deltoids, biceps and pectoral muscles on

Sur la meningite et la myelite dans le mal vertebrale, 1871, p. 58, 59.

†*Sur l' etat de la moelle épiniere durs la carie vertébral*, 1822.

‡*Lancet*, May 22 and 29, 1875.

the other hand performed their functions well. The patient died the seventh day with symptoms of dyspnœa and pneumonia.

With the cervical location of the lesion also appears diplegia of the arms and other symptoms of affection of the cervical cord. As such may be mentioned the oculo-pupillary alterations, more frequently paralytic myosis (contraction from compressive inhibition of conduction), than spastic mydriasis [dilatation from medullary irritation of the dilator pupillæ]. Here belongs also the slowing of the pulse by irritation of the endocardial vagus fibres observed in the already mentioned case of Hutchinson. In a case described by myself* as conclusive in its way as a vivisection, in a student, aged 25, after he had received a punctured wound in the neighborhood of the sixth cervical vertebra, there was hemiparesis of the right side, dilatation of the pupil, and variation of the pulse between 48 and 56 beats, for a period of four weeks. The early dyspnœic troubles are explained also by the involvement of the cervical and upper dorsal origins of the phrenic, cervical, and intercostal nerves. With perfect maintenance of the abdominal respiration the lesion cannot have reached the origin of the diaphragmatic nerves in the fourth cervical pair. Speech and swallowing are also frequently embarrassed. In conclusion we may mention the initial increase of bodily temperature and its subsequent rapid fall.

According to the latest experiments of Schroff† a decided rise of temperature follows section of the spinal cord in dogs. Still a similar phenomenon follows opening of the spinal canal without injury to the cord, also section of the cord at the level of the atlas with artificial respiration, the atmosphere of the room being at 18° or 20° C.

Together with the paralysis of both arms following pressure lesions, there is a second class of spinal paraplegias of the upper extremities. In these a cell atrophy in the anterior gray cornua which serve as origins for the roots of the nerves of the upper extremities is the anatomical substratum for the brachial diplegia. These cases, for the most part only lately

**Zeitschr f. prakt. Heilkunde*, No. 46, 1866.

†*Sitzungsb. der Weiner k. Akad*, Mar. 22, 1876.

investigated, are sometimes acute, sometimes chronic. Their corresponding clinical symptoms show also special peculiarities.

Partial acute myelitis, affecting especially the upper extremities, has been already described by Ollivier (d'Angers),[1] in one case. Here, also, are to be included those observations, of more or less perfect cervical paraplegia, connected with tumors in the gray substance of the cervical cord, where, together with diffusion of the process toward the posterior columns and cornua, the anterior cellular columns are especially involved. Gull[2] reports the case of a child, in whom, with paralysis of the right and left arm, the mobility of the legs was better preserved. The autopsy revealed the seat of a solitary tubercle, at the level of the origin of the 6th and 7th cervical nerves.

With merely partial lesion of the cervical cord, the paralysis is also only partial and unilateral, as in the old case of Eager,[3] and in a more recent observation, by Virchow,[4] in which hyperæsthesia, motor paralysis, muscular atrophy and contractures were present in the left upper thorax and arm. At the post-mortem was found a round tubercular mass, in the left side, at the level of the 3d and 4th cervical vertebræ, eight millimetres in diameter, crowding the gray substance to the right.

It is one of the achievements of recent times, to have shown that the anterior gray medullary columns contain groups of polyclonal nerve cells, the degeneration and pigment atrophy of which are connected with peculiar motor and trophic disorders during life. One series of typical disease forms, and their combination with bulbar or spinal paralysis, are here excluded. It also follows, from the latest clinical and anatomical researches of Prevost and David, Joffroy,[6] Erb,[7] and E. Remak,[8] that the motor nuclei are arranged in stages, one over the other, in the spinal cervical enlargement. So, according to the height and extension of the lesion, the form and grade of the cervical paraplegia suffer considerable alterations.

1 *Traite des Maladies de la Moelle epiniere*, 3d. ed., t. II., 1837, p. 319.
2 *Guy's Hosp. Reports*, 1858, p. 206.
3 *Gottschalk's Sammlung*. 1838, II., p. 65.
4 *Onkologie*, I., p. 636.
5 *Arch. d. Physiologie*, 1874, p. 595.
6 *De la Pachymening cervic. hypertr.* Paris, 1873, p. 87.
7 *Arch. f. Psychiatrie*, V. 1875.
8 *Arch. f. Psychiatrie*, VI. 1875.

In the acute form of cerebral myelitis, the inflammatory processes may become quickly diffused in the cornua, and in cervical lesions the upper members suffer. In a very recently reported case of Raymond,[1] of a previously healthy working man, 21 years of age, in whom, after a severe chill, fever, pain, numbness of the hand, extending upwards to the shoulder, were experienced, with rapidly occurring complete paralysis of the left, and imperfect paralysis, also, of the right upper extremity. On the left side the electro-muscular contractility was locally diminished. The patient died asphyxiated, in twelve days. The autopsy revealed nothing to macroscopic examination. Microscopic examination of the hardened cord, on the other hand, showed in the cervical region, inflammatory alterations of the cells of the anterior horns, with rarefaction and local disappearance of the same. In the connective tissue, there was marked muscular proliferation, and in the hinder part of the lateral columns, certain nerve fibres showed notable enlargement and thickening of the axis cylinder.

Infantile spinal paralysis also depends upon acute myelitic alterations of the anterior spinal tract, with consecutive proliferation and degeneration in the cell mosaic of the anterior columns, as well as in the corresponding roots and medullary cords, as is shown by the recent discoveries of Cornil,[2] Prevost and Vulpian,[3] Charcot and Joffroy,[4] Parrot,[5] Roger and Damaschino,[6] Recklingshausen,[7] myself,[8] and M. Roth.[9] Infantile spinal paralysis, which, as is well known, generally affects the upper or lower extremity, sometimes both lower members, or those of one side of the body, can, nevertheless, in exceptional cases, take on the form of cervical paraplegia. The following case, already published elsewhere by me,[10] may serve as an instance of this form of paralysis occurring in childhood.

1 *Gaz. Médicale de Paris*, 18. 1875.
2 *C. R. Soc de Biol.* 1864.
3 *Gaz. Med. de Paris.* 1866.
4 *Arch. de Physiol.*, etc. 1870.
5 *Arch. de Physiol.*, etc. 1870.
6 *Gaz. Med. de Paris*, 1871, in four cases.
7 *Jahrb. d Kinderheilk*, 1871.
8 *Med. Chir. Rundschau*, February, 1872.
9 *Virchow's Archiv.* 58 Bd., 1873.
10 *Klinik der Nervenkr.* II. Aufl. 1885, pp. 413–414.

In a four-year old Hungarian boy, who, it was stated, had suffered two years before from a diffuse paralysis of all four members, following a short spell of fever, which continued in the two arms, I found, on examination, the right upper extremity livid, much wasted, the skin thick and loose, the musculature everywhere thin. The atrophic, angular shoulder was merely movable a little forward, extension of the arms and fingers impossible, flexion accomplished with difficulty, and the wasted hand fixed in addnction. The deltoid was only slightly irritable by the faradic current on its inner bundles, the same was true of the infraspinatus and pectoralis, the extensors of the arm and fingers did not react at all, the biceps and certain bundles in the atrophied ball of the thumb only very weakly. The galvanic irritability of the tissues of the nerves of the shoulder and arm was tolerably well retained; the paralyzed extensors underwent slow contractions with a strong galvanic current.

The better nourished left upper extremity was, with some exertion, slightly movable forward and outward, the extension of the arm very slow, flexion prompt, motility of the hand and fingers good. I advised continued galvanization of the nerves, and faradization of the muscles. After some eight months, the child was again brought before me, the right arm and shoulder were fuller and more movable, the left nearly well.

This indubitable form of infantile paralysis finds mention, neither in the more recent, nor in the older monographs. Cellular atrophy of the anterior gray columns seems very rare in infancy. Still, cases of this kind have also been observed in Paris. One of those reported by Charcot[1] is to be considered as such.

Recent researches and observations do away with the erroneous view, that the spinal paralysis in question is peculiar to infancy. Recent fuller discoveries in regard to infantile paralysis led to the knowledge of the fact that an analogous disease also affects adults. The keen insight of Duchenne[2] had already, in 1861, recognized that with riper years and with

1 *Lecons sur les Maladies du Syst. Nerv.* 2 Fasc. 1873, p. 131.
2 *Electrization localisee.* 2d. ed.

febrile symptoms, there might occur a rapidly extending paralysis of the limbs, with muscular atrophy, corresponding loss of electric irritability, with intact sensibility, and with subsequent gradual recovery of motility and irritability. Duchenne placed the seat of this hitherto obscure affection in the gray anterior columns of the spinal cord, and called the affection, general anterior spinal paralysis. Soon thereafter, Hallopeau[1] found, in a similar case necroscopically observed, besides atrophy and a fatty degeneration of the paralyzed muscles and nervous branches, the anterior roots gray and degenerated, and in the dorsal and lumbar cord the anterior horns were of a remarkably dark color, and soft to liquefaction.

Latterly, careful clinical observations were made by Frey,[2] Bernhardt,[3] Charcot,[4] Cuming,[5] Erb,[6] etc., which go to prove that acute spinal paralysis of adults, *poliomyelitis anterior acuta* of Kussmaul, in relation to suddenness of development, integrity of sensibility, and extension of muscular consumption, and diminution of electrical irritability, and the latter often only partial recovery, corresponds with the form of spinal paralysis of children in its most essential features. There are also autopsical evidence, of histological identity. In a case reported by Gombault,[7] a woman in the brief space of half an hour was paralyzed in all her limbs, together with sudden atrophy of the muscles, and loss of electrical contractility. After a protracted recovery, months in duration, there remained atrophy and paralysis of the extensors, of the interossei, and muscles of bases of fingers, with a slight claw-like fixation of the hand.

After one year and a half of suffering, there was found, upon section: pigmentary atrophy of the great ganglion cells of the anterior horns, particularly in the cervical and lumbar region, sclerosis of the anterior roots and corresponding nerve-trunks; in the muscles, the well-known results of degenerative pro-

1 *Arch. géner.* 1862.
2 *Berl. klin. Wochenschr*, 1874.
3 *Arch. f. Psychiat. IV.* Bd., 1873.
4 *Proyrés Médical.* 1874.
5 *Ibidem.*
6 *Arch. f. Psych V.* Bd. 1875.
7 *Arch. de Physiol.* Jan., 1873.

cesses. In the most recent case of Cornil and Lepine,[1] the patient being a man 27 years old, there occurred, as a consequence of a cold, paralysis of the legs; after two years of the arms also, with muscular atrophy, diminution or loss of electric excitability, and undiminished sensibility. In patients who died of asphyxia, microscopic examination of the spinal cord revealed atrophy in a high degree, and local lesions in the cells of the anterior horns, the gray substance selerotic, the vessels thickened, besides a descending selerosis of the lateral columns, atrophy of the anterior root, together with granular degeneration of the muscles, the transverse stripes being still recognizable.

Moreover, in *myelitis antica adultorum*, the anatomically demonstrated cell-atrophy is located especially in the gray anterior columns of the cervical portion of the cord. These clinical forms of cervical spinal paraplegia exhibit a striking similarity to the formerly described analogous affection occurring in childhood, as the following case will show: A tradesman, aged 50, was, in Jan., 1873, after a severe cold, attacked with fever and diarrhœa, which, upon subsiding in the second week, left behind extreme weakness of the legs; to which, in about four weeks, was added paralysis of one, and soon of the other arm. Six months later, I found him, upon inquiring among the patients at the water-cure of Dr. Friedman, at Voeslau, suffering from paresis of the remarkably emaciated lower extremities, with a weak, tottering gait. The faradic, as well as the galvanic re-action of the muscles and nerves showed only a quantitative diminution. Both arms and fore-arms were atrophied and paralyzed; so, also, the down-hanging, flexed hands, which presented a remarkable wasting of the first interossens and of the thenar. The excitability of the Nv. radiales to either current was slight, being limited to the supinators and the exten. carp. radiales. The electro-muscular contractility of both sides (even in the carpus of the uninvolved left hand) disappears in the fingers, the galvanic re-action is equally tardy. The first interossens and the palm of the thumbs are not excitable. Sensibility perfect, as proven by Sieveking's æsthesiometer. The function of the sphincters has not suffered.

1 *Gaz. Médic. de Paris.* 11, 1875.

In the course of the summer months, the patient recovered under the influence of hydriatic and galvanic (central and peripheral) treatment, in a remarkable manner.

Walking and going up and down stairs were now possible without assistance, the movements of the shoulder-joints noticeably improved. In electric reaction, the nerves and muscles showed no improvement. When the patient presented himself at the water-cure, in the summer of 1874, he had power over the extensors; and the nourishment of the upper extremities, still, for the most part paralyzed, had become greater. In the course of the next month, there was a noticeable improvement in the motility of the arm and fore-arm; the patient could even dress himself again, feed himself, etc. At last, movements in hands and fingers became freer and firmer. At the end of summer, patient was able to write several lines. There was, however, only slight improvement of faradic and galvanic excitability.

The last form of cervical paraplegia, caused by cell atrophy of the gray anterior columns, which may be conveniently called the amyotrophic form of spinal paraplegia, is double cervical paralysis of the upper extremities, in progressive muscular atrophy.

These cases of paralysis, with atrophy of both upper extremities and muscles (with corresponding cell degeneration on the gray matter of the cervical region) have been described by Valentiner,[1] Luys,[2] Hayem,[3] as well as Schueppel,[4] in consequence of hydromyelitis of the cervical and pectoral regions. If bulbar paralysis and central neurotic trouble along the course of the gray anterior columns, creeping up to the nerve nuclei of the floor of the fourth ventricle (*Rautengrube*), is conjoined with progressive muscular atrophy, as in the observations of Dumenil,[5] Lockhart-Clarke and Radcliffe,[6] Charcot and Joffroy,[7] it shows that the upper extremities alone are attacked preferably by progressive muscular atrophy.

1 *Prager Vierteljahrschr.* 2 Bd. 1855.
2 *Gaz. Med. de Paris.* 32, 1860.
3 *Arch. d. Physiol.* Nr. 2, 3. 1869.
4 *Arch. d. Heilk.* VI. 1865.
5 *Gaz. Hebdom.* 29, 1867.
6 *Brit. Med. Chir. Review.* Vol. XXX. 1862.
7 *Arch. d. Physiol.* 11. 1869.

According to the above explantion of cervical paraplegia, caused by lesion of the spinal centre, we are led to the consideration of another form which arises from an affection of the peripheral nervous system. Brachial paraplegia may be produced by extravasation of blood in the superior nerve roots (cases of Ollivier, Schnetzenberger). Less frequently the trouble arises from caries of the cervical vertebræ, whereby there being cheesy deposits, according to Michaud,[1] of the suppurating posterior ligaments of the spine, the superficies of the dura is excited to inflammatory proliferation and vegetation. The resulting pachymeningitis externa may give evidence of a double paralysis of the upper limbs, by pressure upon the nerves of the axilla, or, in a case described by myself,[2] there was principally paralysis and atrophy of the upper extremities, (with loss of the electro-muscular contractility), to which latter was added paresis of the legs, with difficulty of swallowing. Proceeding from the wall of the pharynx backward, was seen and felt roughness of the cervical vertebræ, particularly anteriorly; the posterior cervical region showed deep pitting and sensibility to pain upon pressure.

The peripheral form of paraplegia of the upper extremities can, further, proceed from a pachymeningitis spinalis interna. This variety, which was carefully observed by Charcot,[3] and which was called *pachymeningitis cervicalis hypertrophica*, takes its origin from the inflammatory growth and thickening of the inner structure of the dura and the contiguous arachnoidea and pia. The spherical induration of the meninges over the spinal axis is, furthermore, to be distinguished from the form earlier recognized by its cervical location, as well as by the circular pressure upon the spinal cord, which, after incipient neuralgic irritation, leads, in two to three months, to a paralysis and contraction of the upper extremities, degeneration of the muscles, and diminution of electro-muscular contractility. Later, the lower extremities are also attached, yet generally in a mild degree. Besides this peripheral form arising from atrophy of the anterior and posterior

1 *Sur la Meningite et la Myelite dans le mal vertébral.* 1871.

2 *Oestr. prakt. Heilkunde*, 48. 1866.

3 Soc. de Biologie. 1869.

roots, there is, according to recent experiments by Joffroy,[1] a central form belonging to an earlier category. This observer found on the cervical enlargment myelitic alterations, with, for the most part, formation of cavities. Here, also, the clinical form of disease was characterized by paralysis and atrophy of the arms, and only single muscles of the hand and finger remained intact.

The diagnostic distinction of the clinical character of the occasional form of cervical paraplegia must depend upon the symptoms of the disease. The peripheral cervical pressure-paraplegia begins with a neurotic paralysis, pain, and hyperalgesia, in the course of certain nerves, followed by anæsthesia, paralysis, and atrophy of corresponding muscles. In the beginning, faradic and galvanic irritability is considerably increased, but becomes less and less; the farado-muscular contractility is diminished, or lost; the galvano-muscular, on the contrary, for a long time heightened. Reflex irritability is, as a rule, extinguished. Sometimes there are, also, trophic disturbances of the skin, nails and knuckles.

For the differentiation of the different forms of peripheral cervical paraplegia, it is necessary to keep in mind the pathological signs. In traumatic injuries of the cervical spinal column (shock, or blow upon the neck), there may follow hemorrhage within the cavities of the vertebræ, and about the centrifugal nerve-roots, with marked injection of the brachial region. In the same variety of cases, besides loss of consciousness, there may appear instantaneous or rapidly-developing paralysis of the upper limbs, in which the paralysis is generally found to be partial, and combined with tonic and clonic contractions in single groups of muscles of the arm. If the lesion goes no further, the symptoms gradually disappear. When there is hemorrhage, which, as in fractures of the cervical vertebræ, is attended with myelitic alterations in the cervical portion, there follows, in addition to the antecedent cervical paraplegia, and increase of temperature, paralysis of the lower extremities, involving the bladder. Upon search, topical examination will reveal deformity from fracture, stiffness, and abnormal position of the head, and painfulness upon pressure and motion.

1 *Sur la Pachymening. cervic. hypertrophique.* Paris. 1873.

Brachial paraplegia, which is sometimes observed with caries of the cervical vertebræ, when it is a consequence of pachymeningeal pressure upon the upper nerve-roots, is among the earlier recognized appearances of a neurotic paralysis. Upon the initial neuralgic symptoms, together with the synchronal hyperalgesia and vaso-motor disturbances, there follow later, paralysis of the arm, atrophy with the reaction anomalies of the wasted muscles depicted above, with loss of reflex excitability.

In the cervical paraplegia, due to pressure-lesion of the cord, on the contrary, the affected muscles are not materially altered, in a long time, in nutrition or electrical re-action and sensibility. The reflex power exhibits very considerable increase, or where the reflex irritability is slight, and later, even entirely lost, there is temporary accession of spontaneous, painful convulsions of the limbs, which may have its origin in heightened excitability of the gray substance in diminished cerebral inhibition.

Those rarer spontaneous muscular contractions, produced for the most part upon passive movements, are to be designated as spinal reflex spasms, and the inappropriate denomination, spinal epilepsy, is to be reserved for those varieties, in which pathological or experimental lesions of the spinal cord, or its nerves (according to Brown-Sequard) manifest themselves in epilepfiform convulsions.

That the double paralysis of the arms attending caries of the cervical segments of the vertebral column, may be occasioned by deep-seated medullary disease, is demonstrated by an old observation by Budd.[1] In the case of a girl who suffered from scrofula with caries of the cervical vertebræ, and retropharyngeal abscess, there was for two years only a paralysis of the upper extremities; and later, also, development of paralysis of the right leg. Under the influence of excitement, likewise upon urination and defecation, there occurred in the paralyzed leg—sometimes also (in mild degree) in the corresponding arm—more or less powerful reflex movements. In a case described by Vogel and Ditmar,[2]

1. *Med. Chir. Transact.*, vol. 22.
2. *Deutsche Klinik*, 1851.

the initial paralysis of the upper, and later, also, of the upper extremities, as the autopsy showed, was connected with exostosis reaching from the third to the fifth cervical vertebræ.

Concerning the possibility of the subsidence of such pressure-paralyses before they pass into a spinal lesion, we are enlightened by an observation of Brown-Sequard's, wherein by a luxation of a spinal dislocation the suddenly-occurring paraplegia disappeared. In a case observed by E. Rollett[1] at Oppolzer's Klinik, the double paralysis of the upper limbs, arising from compression of the cord, disappeared spontaneously. In consequence of inflammation of the highest cervical vertebræ, there resulted, in the beginning, gradual luxation of the epistrophens backwards and downwards, and anchylosis with the atlas. The growing pressure upon the fore part of the spinal cord produced, first, paralysis of the upper, then also of the lower extremities. Not until after the direction of the pressing protuberance was altered in further consequence of fusion of the bones, so that it was directed forward, did the paralysis of the legs disappear in consequence of removal of compression of the cord; later, that of the arms also disappeared. The patient lived a number of years, and finally died of cardiac disease.

Finally the *ensemble* of symptoms deviates from the typical in the third category of double-paralyses of the arms, in amyotrophic forms of cervical paraplegia, caused by cell-degeneration in the gray anterior columns. In circumscribed progressive atrophy of the upper extremities, continuing a long time, the diagnosis is not attended with difficulty. In cervical myelitis, complication with bulbar paralysis, with participation of the nervous substance, points to ascending inflammatory processes in the anterior horns.

Paraplegia of the upper extremities in childhood is very rare, and, as my case described above shows, will be diagnosticated without difficulty, on account of the characteristic forms of the paralysis, and atrophy of the affected arms. In the correct interpretation of the symptoms, only intra-medullary nerve-formations in the cervical portion could cause any difficulty. Cases in children may be developed under the guise

1. *Med. Wochenschr.* 24–26, 1864.

of infantile spinal paralysis, as is shown by the following case reported by Gull:[1]

In an infant eight months old there was at first gradual paralysis of the right arm, and after fourteen days the left was involved. The head was drawn down between the shoulders, the neck stiff. After 2½ months both upper extremities, especially the right, were much emaciated, and hung motionless by the side of the trunk.

The legs failed in nourishment and motility considerably, and showed frequent spasmodic contractions, particularly in the right, weaker leg. The urine was ammoniacal. The involuntary motility of the lower limbs lasted in a measure to the time the child died, in the 7th month of the disease.

Upon section there was found on the under side of the cervical enlargement, opposite the origin of the sixth and seventh cervical nerves, a solitary tubercle, which had caused the compression of the cord with perfect absorption of the tissues. The swelling appeared to have proceeded from the right back and neighboring parts of the lateral fibres. Due consideration of the symptoms, especially the drawing down of the head between the shoulders, the stiffness of the neck, the periodical spasmodic movements of the legs, together with the ammoniacal character of the urine, gives us sufficient data for a conclusion that we are dealing with the usual form of spinal paralysis of children, and for the elimination of the symptoms of pressure-myelitis.

In regard to the recently-considered *myelitis antica adultorum* (the poliomyelitis anterior antica of Kussmaul), there remains to remark, in conclusion, that, according to my observations above, as well as a recent like communication by Carl Weiss,[2] the febrile beginning, the simultaneous paralysis of the legs, and later, of the arms, the rapid atrophy of the muscles, and their resistance, the absence of disturbances of sensibility, or of the sphincters, of potency, with progressive return of motility, is sufficient for a diagnostic decision. As signs of distinction from progressive muscular atrophy, the following are peculiar to poliomyelitis: the initial form, some-

1. *Guy's Hospit. Rep.*, 1858.
2 Inaug. Dissert., Breslau, 1875.

times with brain symptoms, the rapidly developing muscular atrophy, the paralysis ascending, as a rule, from the lower to the upper extremities; the speedy improvement of the legs, the paraplegia of the arms persisting, the gradual equalization of the intensive and extensive motor disturbances, and very tardy return of electric reaction.

The prognosis of cervical paraplegia is dependent upon the character of the primary lesion. Worst obviously in the paraplegic forms in pressure-myelitis, for cases like the above-mentioned, where the pressure-paralysis is corrected by nature or art, are very rare. The arm-paraplegias of acute myelitis share the fate of the quickly fatal intercurrent affection. Among the chronic myelitic affections, the so-called amyotrophic forms of cervical paraplegia, arising from progressive muscular atrophy, have the most unfavorable character, if they are associated with bulbar paralysis. In infantile double paralysis of the arms, only a partial improvement of the unequally-affected extremities is to be expected. In anterior poliomyelitis, judging from my own experience, and that of C. Weiss, we may expect, when the individuals are previously sound and in good circumstances, and when there is a rapid disappearance of paresis of the legs, sometimes a complete subsidence of the disease. On the contrary, the course of that variety of anterior poliomyelitis, in which, conjoined with double paralysis of the arms, there is later paralysis of the other limb, is unfavorable, as also (as I witnessed in two cases) where there are indications of atrophy of the optic nerve, and paralysis of the nervous nuclei, complicating the case. Finally the cervical paraplegias of the peripheral variety, those caused by hemorrhage about the upper nerve-roots, and those resulting from pachymeningitis cervicalis hypertrophica, are susceptible of treatment. In the last-named variety spontaneous recovery was repeatedly observed by Charcot, and this fact, in particular, is to be kept in mind the pretensions of therapeutics to the contrary notwithstanding.

The treatment of the form of cervical paraplegia in question must be directed toward furthering absorption, as well as toward the enlivening the circulation and innervation of the parts involved.

In the beginning, moderate doses of iodide of potassium, warm baths and thermal springs, are indicated. Later, mild hydriatic remedies are to be recommended, (which are to be preferred to half baths, cool dorsal douches, as well as their combination with moist rubbings and packs).

In electrical treatment, the constant galvanic spinal current and labile currents directed along the nerve roots, and their course in the paralyzed members.*

In stubborn paralysis and muscular atrophies, the nerves may be galvanized, and the muscles subjected to the induced current.

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* [In obstinate cases of paralysis and muscular atrophy, alternate treatment of the nerves with the galvanic, and of the muscles with the induced current, may be of service.